REMARKS

Claims 2, 4-6, 8, 10, 12, 16-18 and 20 have been amended. New claim 24 has been added, and claims 1, 3, 15 and 23 were previously cancelled. Accordingly, upon entry of the above amendments, claims 2, 4-14, 16-22 and 24 will be pending and under consideration.

Claim Objections

The Examiner has objected to claims 4, 6, 8, 10, 12, 16-18 and 20 based on numerous informalities, relating primarily to inconsistencies in terminology. The Examiner's careful consideration of the claims and suggested corrections are duly noted and appreciated. It is believed that the above amendments to the claims address all of the claim objections. In addition, claim 2 has been corrected to claim a "component" of claim 4, rather than a "compound."

Prior Art Rejection Based On Kaminaga Et Al. In view Of Matayabas, Jr. Et Al.

Claims 2 and 4-10 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Kaminaga et al. (U.S. Patent No. 6,257,215) in view of Matayabas, Jr. et al. (US Published Application No. 2004/0191503).

Applicants agree with the Examiner that Kaminaga et al. disclose an electrical component encapsulated, overmolded and/or underfilled with a polymeric composite including a synthetic resin matrix and inorganic filler particles substantially uniformly distributed in the matrix. Applicants also agree with the Examiner that Kaminaga et al. do not disclose the use of particles having a platelet structure, and do not disclose an inorganic filler content of 20% or less based on the weight of the polymeric composite. Applicants also agree with the Examiner that Matayabas, Jr. et al. disclose a semi-conductor device and a phase change thermal interface material having particles with a platelet structure, and that the platelet particles may comprise less than 20% of the phase change thermal interface material. Applicants disagree with the Examiner's conclusion that it would have been obvious to one having ordinary skill in the art at time the invention was made to substitute the particles of Kaminaga et al. with the platelet particles described by Matayabas, Jr. et al.

The Examiner alleges that a person of ordinary skill in the art would have been motivated to make the substitution "for the purposes of aiding exfoliation in the composite and improving the strength of the polymer/clay interface and reducing diffusion of gasses and low molecular weight components through the material (para 0044 and para 0045)."

The proposed substitution is inconsistent with the teachings of Kaminaga et al., and is not motivated by the teachings of Matayabas, Jr. et al. Kaminaga et al. teach that the filler should be comprised of rounded (i.e., spherical) particles in order to eliminate or reduce damage during encapsulating, overmolding and/or underfilling. Further, Kaminaga et al. teach that the underfill, overmolding, or encapsulating composition is a filled epoxy resin. The purpose of using platelet fillers in the phase change thermal interface materials described by Matayabas, Jr. et al. is not at all relevant to epoxy resins used for underfilling, overmolding and/or encapsulating an electrical component. The disclosed functions of the platelet particles in the Matayabas, Jr. et al. publication are to improve thermo-oxidative stability and to reduce "pump-out", "bleed-out" and "dry-out." These problems are not the same as or reasonably related to the intended function of the rounded filler in the epoxy resin of Kaminaga et al.

Matayabas, Jr. et al. disclose an electronic device, such as a semi-conductor package 100, comprising a flip chip 103 mounted to a substrate 101, such as a printed circuit board, via solder bumps 102. A heat spreader 105 is thermally coupled to flip chip 103 through a compliant heat-transfer medium or thermal interface material 104. In the illustrated embodiment, flip chip 103 is not overmolded or encapsulated. However, it is disclosed that the gap between flip chip 103 and substrate 101 "may be filled with an epoxy underfill material (not shown)." Thus, rather than teaching or suggesting that the platelet filler particles should be used in an underfill, Matayabas, Jr. et al. teach the use of a conventional epoxy resin underfill.

The thermal interface material 104 of Matayabas, Jr. et al. includes one or more matrix polymers, one or more thermally conductive fillers, and one or more clay materials. Thermal interface material 104 serves primarily as an adhesive for bonding heat spreader 105 to flip chip 103 and/or bonding heat sink 106 to heat spreader 105. There is not the slightest suggestion that thermal interface material 104 or 108 should be used as an underfill,

overmolding or encapsulating composition, or that the platelet filler particles would be useful in overmolding, underfilling and/or encapsulating compositions.

Thermal resistance across thermal interface materials 104 and 108 of Matayabas Jr. et al. is minimized by making the joint 104, 108 as thin as possible, by maximizing thermal conductivity, and by minimizing gaps between the contacted surfaces (of heat sink 106, heat spreader 105 and flip chip 103). The matrix polymer used in the thermal interface material 104, 108 is a polyolefin, such as polyethylene, polypropylene, polystyrene, paraffin wax, unsaturated olefin rubbers, and saturated rubbers (e.g., EPDM). Disclosed thermally conductive fillers that may be incorporated into the thermal interface material include ceramics, such as aluminum oxide, boron nitride, and aluminum nitride; metals, such as aluminum, copper, and silver; and solders, such as indium. Clay materials that may be used in the thermal interface material include smectite clays, such as montmorillonite. The clay material is added to reduce the rate of diffusion of gasses and low molecular weight components through the thermal interface material. This provides "improved thermo-oxidative (bake) stability" and "dry-out will be lessened." Thermo-oxidative (bake) stability is a problem with phase change thermal interface materials having an olefinic polymer matrix. This is not a problem associated with epoxy resin underfills as described in the Kaminaga et al. patent. "Pump-out", "bleed-out" and "dry-out" are also problems associated with the previously known thermal interface materials having an olefinic polymer matrix. Again, these problems are not relevant to the epoxy resin underfill, overmolding and/or encapsulating compositions disclosed by Kaminaga et al.

There is no suggestion in the prior art that thermal interface materials are suitable for overmolding, encapsulating or underfilling an electrical component. As defined in Applicants' specification (paragraph 13), the term "overmolding" refers to an arrangement in which the protective polymer material together with a substrate completely encases a subcomponent. The term "encapsulating" is defined as an arrangement in which the protective polymer material completely surrounds or encases the component. The term "underfill" is defined as an arrangement in which the protective polymer fills a space between a substrate and a subcomponent. Matayabas Jr. et al. teach using the allegedly improved thermal interface material for its <u>intended</u> purpose, namely, to bond a heat spreader to an electrical

subcomponent and/or to bond a heat sink to a heat spreader. The use of a platelet filler in a thermally conductive, olefin polymer based adhesive does not suggest use of the same filler in an epoxy resin underfilling, overmolding and/or encapsulating composition.

Kaminaga et al. disclose two primary requirements for the filler used in an epoxy encapsulating composition. First, the epoxy composition contains an inorganic filler selected and utilized in an amount "specifically adjusted to permit its resultant linear expansion coefficient . . . [to be] midway in value between the linear expansion coefficient of said power semiconductor device and that of said heat sink." See column 3, lines 1-5. Second, Kaminaga et al. teach that the filler should be round (spherical) so as to "reduce or minimize risks of damage at semiconductor components." See column 6, lines 10-21. In order to achieve the desired coefficient of thermal expansion, Kaminaga et al. recommends a higher than conventional filler loading of 70% to 90%. Matayabas Jr. et al. does not teach or suggest that the disclosed platelet filler particles will provide a desirable coefficient of thermal expansion, or that the platelet particles can be used in a suitably low amount to achieve the desired coefficient of thermal expansion without causing risk of damage to electrical components during flow of an overmolding, underfilling and/or encapsulating composition. The alleged motivation of "aiding exfoliation in the composite and improving the strength of the polymer/clay interface and reducing diffusion of gasses and low molecular weight components through the material" is without any relevance with respect to the epoxy encapsulating compositions disclosed by Kaminaga et al. Exfoliation refers to a process for distributing platelet particles with a high degree of separation. In the absence of a platelet particle, the concept of "exfoliation" is completely meaningless. There cannot be a motivation for "aiding exfoliation in the composite" unless there is first some other motivation for utilizing platelet particles in an underfill, overmolding and/or encapsulating composition. There cannot be a motivation to strengthen the polymer/clay interface, unless there is first a motivation for utilizing a clay filler. Moreover, the applied references are completely devoid of any discussion pertaining to strengthening of a polymer/clay interface. Finally, the alleged motivation of "reducing diffusion of gasses and low molecular weight components through the material" is only disclosed to be a problem relevant to olefinic phase change thermal interface

materials, not the filled epoxy resin underfilling, overmolding and/or encapsulating compositions of Kaminaga et al.

In summary, factors which would motivate a person of ordinary skill in the art to utilize low levels of a clay platelet filler in an olefin polymer based phase change thermal interface material would not motivate a person of ordinary skill in the art to utilize low levels of a clay platelet filler in the epoxy resin compositions of Kaminaga et al., since to do so would be contrary to the teachings of Kaminaga et al. which suggests round silica or glass particles at high levels (70%-90%), and since the prior art does not provide any teaching or suggestion that clay platelet filler particles will impart the desired coefficient of thermal expansion or suitable rheology that will avoid damage to electrical components during flow of the epoxy resin composition during underfilling, overmolding and/or encapsulation. For these reasons, the prior art references cannot establish *prima facie* obviousness for the claimed invention.

<u>Prior Art Rejection Based On Kaminaga Et Al. In View Of Matayabas, Jr. Et Al. And Further In View Of Capote Et Al.</u>

Claim 12 has been rejected under 35 U.S.C. §103(a) as being unpatentable over Kaminaga et al. in view of Matayabas, Jr. et al. as applied to claim 4, and further in view of Capote et al. (U.S. Patent No. 6,335,571).

Dependent claim 12 is allowable for the reasons set for above with respect to claim 4. Further, while the Capote et al. patent discloses an appropriate CTE for an underfill composition, it does not provide any teaching or suggestion that the clay platelet particle fillers of Matayabas Jr. et al. can be employed in an appropriate amount that will achieve the desired CTE taught by Kaminaga et al., while also avoiding risk of damage to the electrical component during underfilling, overmolding and/or encapsulation.

<u>Prior Art Rejection Based On Chuang Et Al. In View Of Matayabas, Jr. Et Al.</u>

Claims 4 and 10-11 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Chuang et al. (US Published Patent Application No. 2004/0084758) in view of Matayabas, Jr. et al.

The Examiner believes that Chuang et al. discloses "an electrical component 31 or 36 encapsulated and overmolded with a polymeric composite including a thermoplastic resin matrix 39, wherein the thermoplastic resin is selected from polycarbonates and polyester (cover fig., para 0027)." Applicants do not agree with this assessment. It appears that thermoplastic encapsulant 39 does not encapsulate or overmold electrical component 31 or 36, but instead partially encapsulates a first encapsulant 38, which encapsulates the electrical component. Thus, it is not the electrical component that is encapsulated by thermoplastic encapsulant 39, it is a first encapsulant 38 that is partially encapsulated by thermoplastic composition 39.

Applicants agree with the Examiner that Chuang et al. do not disclose a matrix comprising inorganic filler particles having a platelet structure or an inorganic filler content of 20% or less.

While Applicants agree that Matayabas Jr. et al. disclose a semi-conductor device and the use of inorganic filler particles having a platelet structure in a phase change thermal interface material, this does not teach or suggest the use of the same platelet filler materials in an entirely different context to perform an entirely different function.

The Examiner has alleged that one having ordinary skill in the art would have been motivated to modify Chuang et al. by utilizing an inorganic filler having a platelet structure as taught by Matayabas Jr. et al. "for the purposes of aiding exfoliation in the composite and improving the strength of the polymer/clay interface and reducing diffusion of gasses and low molecular weight components through the material (para 0044 and para 0045)." As stated above, with respect to the rejection of claims 2 and 4-10 based on the teachings of Kaminaga et al. in view of Matayabas Jr. et al., the alleged motivation is not relevant to the function of an overmolding, underfilling and/or encapsulating composition. There cannot be motivation for aiding exfoliation in a composite, unless there is <u>first</u> motivation for utilizing a platelet filler in such composite, since exfoliation is without meaning in the absence of platelet particles. Similarly, there can be no motivation for improving the strength of a polymer/clay interface, unless there is <u>first</u> motivation for utilizing a clay filler. Further, the prior art is utterly silent with respect to strengthening a polymer/clay interface. Finally, the use of platelet particles to reduce diffusion of gasses and low molecular weight components through olefinic polymers to

prevent "pump-out", "dry-out", and/or to improve thermo-oxidative stability is not reasonably related to overmolding, underfilling and/or encapsulating compositions. In fact, one need only refer to the Kaminaga et al. patent to learn that the claimed low organic filler loadings and platelet fillers are contrary to conventional wisdom, which is to use round particles at high levels (e.g., 70%-90%).

In summary, the disclosed motivation for using platelet particles in a phase change thermal interface material are not relevant to underfilling, overmolding and/or encapsulating compositions, which are used for an entirely different purpose and require entirely different properties. Applicants have discovered that platelet particles can be used at low levels (e.g., 20% or less) to achieve a suitable coefficient of thermal expansion, without adversely affecting the rheology of the composition prior to curing. This is not taught or suggested by the prior art, but is in fact contrary to the teachings of the prior art. Accordingly, the rejection should be withdrawn.

Prior Art Rejection Based On Kaminaga Et Al. In View Of Murakami Jr. Et Al.

Claims 13-14 and 20 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Kaminaga et al. in view of Murakami et al. (U.S. Patent No. 6,081,023).

As before, Applicants agree that Kaminaga et al. disclose an electrical component encapsulated, overmolded and/or underfilled with an epoxy package matrix 7 and an inorganic particulate filler, but do not disclose a thermoplastic resin matrix. Applicants agree that Murakami et al. disclose a semi-conductor device comprising a semi-conductor chip 1, electrical leads $3A_1$ and $3A_2$, and a resin molding 6 disposed on chip 1, and partially embedding leads $3A_1$ and $3A_2$, wherein the resin molding may be a composite material comprising a thermoplastic resin and an inorganic particulate filler. However, resin molding 6 does not underfill, overmold or encapsulate an electrical component. Accordingly, neither Kaminaga et al. nor Murakami et al. teach or suggest utilizing a filled thermoplastic resin as an overmolding, underfilling or encapsulating composition for an electrical component.

The Examiner has suggested that one having ordinary skill in the art would have been motivated to utilize the thermoplastic resin composition of resin molding 6 in place of the

epoxy resin composition disclosed by Kaminaga et al. in order to improve affinity between the electrical component and the underfilling, overmolding, and/or encapsulating composition to reduce peeling at the composite-component interface. However, neither of the applied references teach nor suggest that there is a problem with peeling of known underfilling, overmolding and/or encapsulating compositions from electrical components, and neither reference teaches nor suggests that such speculative problems can be solved by replacing epoxy resin compositions with thermoplastic compositions. Accordingly, there is no teaching, suggestion or motivation for replacing the epoxy resin compositions of Kaminaga et al. with thermoplastic compositions as described by Murakami et al. Thus, the rejection of claims 13-14 and 20 should be withdrawn.

Prior Art Rejection Based On Chuang Et Al. In View Of Matayabas, Jr. Et Al.

Claims 13 and 16-20 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Chuang et al. in view of Matayabas Jr. et al.

As stated before, Applicants disagree with the Examiner's statement that Chuang et al. disclose an electrical component encapsulated and overmolded with a polymeric composite including a thermoplastic resin matrix 39. Resin matrix 39 partially encapsulates a first encapsulant 38 that encapsulates the electronic device. Thus, the electrical device is not encapsulated, underfilled or overmolded with thermoplastic resin matrix 39. Further, the teachings of Matayabas Jr. et al. relate to the use of a particulate filler in a phase change thermal interface material, not in an overmolding, underfilling and/or encapsulating composition. The known requirements for a particulate filler in a phase change thermal interface material are different from those of a particulate filler in an overmolding, underfilling and/or encapsulating composition. As previously stated, the alleged motivation of "aiding exfoliation in the composite and improving the strength of the polymer/clay interface and reducing diffusion of gasses and low molecular weight components through the material (para 0044 and para 0045)" are not relevant to overmolding, underfilling and/or encapsulating compositions. Specifically, there is no need to aid exfoliation in the composite or to improve the strength of a polymer/clay interface, unless there is first motivation for utilizing a clay platelet filler in a composite, since the expression "exfoliation" as used in the Matayabas Jr. et

al. patent is only relevant to the manner in which a platelet filler is distributed in a polymer matrix (i.e., the degree of separation of the individual platelets), and because there is no motivation for improving the strength of a polymer/clay interface, unless there is first a clay filler. Moreover, the prior art is absolutely devoid of any teaching relevant to strengthening a polymer/clay interface. As previously stated, the need for reducing diffusion of gasses and low molecular weight components through an olefin polymer based phase change thermal interface material is completely irrelevant to underfill, overmolding and/or encapsulating compositions. For these reasons, the rejection should be withdrawn.

Prior Art Rejection Based On Kaminaga Et Al. In View Of Matayabas, Jr. Et Al.

Claims 13, 14 and 16-19 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Kaminaga et al. in view of Matayabas Jr. et al.

Applicants agree with the Examiner that Kaminaga et al. do not disclose an underfill, overmolding, and/or encapsulating composition comprising a thermoplastic resin matrix. However, while Matayabas Jr. et al. disclose a phase change thermal interface material comprising a montmorillonite filler in an amount of 0.5 weight percent to 25 weight percent, it is Applicants' belief that this would not have suggested the use of montmorillonite or any other platelet filler as a substitute for the round filler particles and high filler particle levels (70%-90%) advocated by Kaminaga et al. for underfilling, overmolding and/or encapsulating compositions.

The use and properties of phase change thermal interface materials are different from those of overmolding, underfilling and/or encapsulating compositions, and the purpose of the fillers used in phase change thermal interface materials are different from the purpose of fillers used in overmolding, underfilling and/or encapsulating compositions. The reasons that Matayabas Jr. et al. uses platelet fillers in a phase change thermal interface material are not relevant to the requirements of an overmolding, underfilling or encapsulating composition. It is alleged that one having ordinary skill in the art would be motivated to use montmorillonite as a substitute for the round silica or glass filler particles of Kaminaga et al. "for the purposes of aiding exfoliation in the composite and improving the strength of the polymer/clay interface

and reducing diffusion of gasses and low molecular weight components through the material (para 0044 and para 0045)." However, there cannot be any motivation for aiding exfoliation of a clay filler or improving a polymer/clay interface, unless there is first motivation for utilizing a clay filler in an underfilling, overmolding and/or encapsulating composition. The known requirements for underfilling, overmolding and/or encapsulating compositions are that they have a coefficient of thermal expansion that is about midway between that of an electrical device and a substrate on which it is mounted and that they do not adversely affect rheology of the composition (according to Kaminaga et al.). There is no suggestion in the prior art that platelet filler particles would achieve this desired coefficient of thermal expansion. Further, Kaminaga et al. also disclose that the filler should be round to avoid damage to the component during underfilling, overmolding and/or encapsulating. Thus, the use of platelet structures is contrary to the teachings of Kaminaga et al. There is no motivation for utilizing platelet fillers in an overmolding, underfilling and/or encapsulating composition. The alleged motivation for reducing diffusion of gasses and low molecular weight components is only disclosed to be an issue with olefinic based phase change thermal interface materials, and is not a problem with the epoxy resin underfill, overmolding and/or encapsulating compositions described by Kaminaga et al. For these reasons, the rejection should be withdrawn.

Prior Art Rejection Based On Kaminaga Et Al. Or Chuang Et Al. In View Of Matayabas, Jr. Et Al. Or Murakami Et Al.

Claims 21 and 22 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Kaminaga et al. or Chuang et al. in view of Matayabas Jr. et al. or Murakami et al. as applied to claim 13 above, and further in view of Yu et al. (U.S. Patent No. 5,153,657)

Dependent claims 21 and 22 are allowable for at least the reasons set forth above with respect to independent claim 13.

SUMMARY AND CONCLUSION

Matayabas Jr. et al. only teaches the desirability of using platelet fillers, such as montmorillonite, to improve the properties of olefin polymer based phase change thermal interface materials. There is no suggestion that the reasons for using a platelet filler in a phase change thermal interface material is in any way relevant to the function of fillers in an

overmolding, underfilling and/or encapsulating composition. For such compositions, filler types and filler amounts are selected to adjust the coefficient of thermal expansion without adversely affecting pre-cure rheology. The prior art does not provide any teaching relevant to achieving these objections with platelet filler particles. Accordingly, there is no motivation in the prior art for utilizing platelet fillers in an overmolding, underfilling and/or encapsulating composition as claimed.

The Chuang et al. patent discloses a thermoplastic second encapsulant that partially encapsulates a first encapsulant that encapsulates an electrical device. This does not suggest encapsulating an electrical component with a thermoplastic encapsulant (i.e., partially encapsulating an encapsulant with a thermoplastic resin is not the same as encapsulating an electrical component with a thermoplastic encapsulant). The Murakami et al. patent only discloses partially encapsulating an electrical conductor, not an electrical device, in a thermoplastic resin, and does not teach or suggest encapsulating an electrical component in a thermoplastic resin. Thus, none of the prior art of record teaches or suggests a thermoplastic encapsulating, overmolding and/or underfilling resin composition.

It is respectfully submitted that the claims are in condition for allowance and notice of the same is earnestly solicited.

Respectfully submitted,

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